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ABSTRACT

Three studies were conducted to investigate the development of the ability of individuals of varying ages to use macrorules for paraphrasing expository text. Macrorules were defined as the general rules of deletion, superordination, selection, and invention that underlie comprehension of prose. In the first study, 18 fifth grade, 16 seventh grade, 13 tenth grade, and 20 college students were given expository texts and told to summarize them. They were allowed to do anything that would help them write good summaries, including taking notes, underlining text, writing rough drafts, and keeping their notes and rough drafts at hand while summarizing. The results were marked for use of macrorules by independent raters. In the second study, college rhetoric instructors ("experts") completed a similar task. In addition to summarizing the material, they were asked to talk about their methods for completing the task and about how they taught their students to summarize. In the third study, 20 junior college students ("novices"), completed a similar task. Results showed that older high school students, college students, and "experts" wrote better and used rules more efficiently while writing than did younger students and novice writers. There was also a marked tendency on the part of more mature students to rearrange material across paragraphs, combining according to common topic. (FL)

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Technical Report No. 270

MACRORULES FOR SUMMARIZING TEXTS: THE DEVELOPMENT OF EXPERTISE

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Macrorules for Summarizing Tests: The Development of Expertise

The ability to summarize information is an important study skill involving both comprehension of, and attention to, importance at the expense of trivia. Recent evidence suggests that this may be a late developing skill. When writing summaries, college and older high school students outperform younger children in their propensity to plan ahead, in their sensitivity to fine gradations of importance in the text, and in their ability to condense more ideas into the same number of words (Brown, Day, & Jones, in press). The ability to recursively work on information to render it as succinctly as possible requires judgment and effort, knowledge and strategies.

When children are asked to summarize age-appropriate material, they are able to employ simple deletion procedures at a relatively early age. For example, Johnson (1978, in press) asked grade school and college students to orally summarize well-formed stories. The standard strategy of the children was deletion, but children as young as first grade did use some transformational condensation rules; approximately 30% of the summary units produced by first, third and fifth graders represented story nodes by transformations of the original text content, compared with 60% for college students. Using a more difficult task, writing a summary of much longer, and less well-formed stories, Brown, Day, and Jones (in press) found that fifth graders were able to delete both trivial and redundant material but there was little evidence of more complex transformational rules of condensation until the later high school years.

In the Brown, Day, and Jones study, fifth and seventh graders, required to write a summary of a lengthy story, appeared to treat the task as one of deciding if to include or delete elements that actually occurred in the surface structure of the original text. Brown et al referred to this as the copy-delete strategy. In general the strategy is as follows: (a) read text elements sequentially; (b) decide for each element on inclusion or deletion; (c) if inclusion is the verdict, copy it more or less verbatim from the text. The same general strategy is employed by fifth and seventh grade notetakers (Brown & Smiley, 1978) and outliners (Brown, 1981). Interviews conducted with seventh-eighth grade students concerning their study and research habits again suggest that this is a common method. The students often reported that they copy verbatim from research sources when preparing papers; they had little appreciation of the need to extract the main points and restate them in their own words.

In contrast, the strategy of older high school and college students in the Brown, Day, and Jones study differed radically from the copy-delete ploy. They systematically departed from both the surface wording and the temporal sequence of the text, combining across paragraphs, rearranging by topic cluster and stating the gist in their own words. They relied heavily on transformational rules to produce a synopsis in their own words of the essential meaning of the text.

In this paper, we will examine the basic condensation rules employed by children and adults as they summarize expository texts rather than stories. But what are these rules? In the summarization model proposed by

van Dijk and Kintsch (van Dijk & Kintsch, 1977; Kintsch & van Dijk, 1978), the information to be included in a summary is determined by macrorules (processes of deletion, generalization and integration) that operate on the propositions of the input text to produce a macrostructure. Based on this analysis and an informal consideration of summarization protocols obtained from children and adults, we identified six basic rules of summarization.

Two of the six rules involve the deletion of unnecessary material. One should obviously delete material that is trivial, and even grade school children are quite adept at this if the form and content of the material is familiar (Brown, Day, & Jones, in press; Johnson, 1978). One should also delete material that, although it is important, is also redundant. Kintsch and van Dijk's system also includes these two deletion rules. Two of the rules of summarization involve the substitution of a superordinate term or event for a list of items or actions. For example, if a text contains a list such as: cats, dogs, goldfish, gerbils and parrots, one can substitute the term pets. This is Kintsch and van Dijk's generalization rule. Similarly, one can substitute a superordinate action for a list of subcomponents of that action, i.e., John went to London, for: John left the house, John went to the train station, John bought a ticket, etc., etc. This is roughly comparable to Kintsch and van Dijk's (1978) integration rule. The two remaining rules have to do with providing a summary of a main constituent unit of text, the paragraph. The first rule is -- select a topic sentence, if any, for this is the author's summary of the paragraph. The final rule is -- if there is no topic sentence, invent your

own. These operations are roughly equivalent to Kintsch and van Dijk's construction rule.

These basic rules seem to capture the essence of the methods of condensation actually used by students when engaged in the formal task of summarizing, they also seem to be the rules used by more mature high school students when notetaking and outlining (Brown, 1981; Brown & Smiley, 1978). Kintsch and van Dijk argue that these macrorules of deletion, superordination, selection and invention are general rules underlying comprehension of texts, not just specific rules for carrying out a summary writing task.

Three studies are reported here. In the first study, we examine the developmental trend associated with the use of macrorules when paraphrasing expository texts. In the second study, we examined experts' use of summarization rules using on-line "talk aloud" protocols. Following our consideration of experts we turned our attention to novices; in the third study we examined the potential diagnostic power of our developmental norms by considering the performance of junior college students, a population known to experience problems in critical reading and effective studying.

EXPERIMENT 1

Method

Subjects. The subjects were 18 fifth graders, 16 seventh graders, 13 tenth graders and 20 college students. Their mean ages were 10.7, 13.11, 15.4 and 18.1 respectively. To the best of our knowledge they were experimentally naive. The fifth, seventh, and tenth graders were from

rural Central Illinois. According to their teachers, they had no discernible reading problems and they were not receiving any extra help with reading or study skills. The college students were freshman University of Illinois undergraduates enrolled in an introductory psychology class.

Materials. Two expository texts[1] were constructed for use in Experiments 1-3. We selected, modified and rewrote suitable seventh grade geography texts to serve the purposes of this study. One text, entitled "Desert," was about how plants and animals survive the harsh desert climate. The other text, "Noise," was about the adverse effects that noise can have on one's health and hearing. Both texts were rewritten so that they were of approximately equal length (492 and 532 words, 36 and 42 lines), comparable readability level (Dale-Chall readability scores of 5.29 and 5.32), and of approximately the same number of idea units (81 and 68, as determined by 15 college student raters). The idea units were rated in terms of their structural importance to the text by 11 additional college students.

All texts were constructed so that five of the six rules could be used. Across texts, the number of segments that would elicit each type of rule was held roughly constant. Each rule could be applied at least three but never more than five times on any given text. The five rules (with van Dijk and Kintsch [1977] terms in parentheses) were (1) deletion (deletion) of unimportant or trivial information, (2) deletion (deletion) of redundant information, (3) superordination (generalization) of lists, i.e.,

substitution of a category name for instances of a category, (4) selection of a topic sentence, i.e., near verbatim use of a topic sentence from the text and (5) invention (construction), i.e., creation and use of a topic sentence that did not appear in the text but easily could have.

The first deletion rule was to eliminate unimportant information from the summary. To encourage the use of this rule, the texts were written so that they contained minor details about the topics, details that independent college students rated as unimportant. Importance was defined as those units receiving a rating of 3 or 4 on a four point scale. The second deletion rule was to eliminate redundancy. Redundant information was included in the texts by rewording and then restating some of the more important sentences. All redundant information received a 3 or 4 importance-level rating. Therefore, unimportant and redundant information did not overlap.

The texts were written so that the superordination of lists rule could be applied three times. Each text contained lists of category members whose superordinates were familar to grade school children. For example, in the desert text, flowers would be an appropriate superordinate for the list of exemplars: "daisies, poppies, marigolds and lilies."

Finally, in order to make the selection and invention rules generally applicable across texts, paragraphs were written around and in support of a topic sentence. College students rated all topic sentences as highly important. For cases where selection was appropriate, the topic sentence was left in the text and read by the subject. For invention, the topic

sentence was deleted, and minor stylistic changes were made to the text to make it read smoothly.

A final pilot study was run to find out if subjects would use the topic sentence rule for each paragraph if it appeared explicitly in the texts. A version of the texts that contained all the topic sentences was given to groups of undergraduates to summarize. Their summaries were just as likely to include topic sentences on those paragraphs targeted for selection as on those targeted for invention tests, suggesting that the paragraphs themselves were similar with the exception of the main manipulation, presence or absence of an explicit topic sentence.

During and after the calibration of the texts, sections were rewritten to ensure normal discourse cohesion and flow. When the texts were finally rated and calibrated it was possible to predict where each of the five rules should be used and the dependent measure was the number of times a rule was used given that it was appropriate. In summary, the texts were constructed specifically to elicit each of the rules of summarization. Furthermore, reading difficulty was held constant, the frequency of occurrence of each rule type was controlled, and the appropriate rule could be identified in advance.

Procedure. Fifth, seventh, and tenth graders were tested as a class in two forty-minute sessions. The college students were also tested as groups but in one one-hour period. Half of the subjects within each age group read "Noise" first and half read "Desert" first. Subjects were given a text and asked to read it three times. After reading, they were asked to

write what they thought was a good summary of the text. When they had completed their first summary, they were asked to put it aside and to write a 60 word summary; this was selected because it was the approximate length taken by a group of experts when asked to provide a brief but coherent summary of these texts. Subjects were told to do anything that would help them write good summaries. They could take notes, underline the text, write rough drafts, and keep the text and their notes in front of them. However, they were not allowed to use their unconstrained summaries when writing the 60 word summaries. At the end of the session, all the materials were collected. The procedure was repeated in the second session using the text not previously summarized.

The summaries were corrected for spelling and punctuation and then typed onto index cards so that information concerning age and condition would not be available to the raters. They were then scored by two independent raters, with an inter-rater reliability of .96.

Results and discussion. There were five summarization rules that could be employed. Because of wide variability with age in the use of these rules separate analysis of variance were conducted on each rule type. Stories were treated as a fixed effect, as the artificial construction of these stories was such that generalization to the class of naturally occurring stories was not thought reasonable; these stories were designed to be most likely to elicit the strategies under consideration. Occasionally a main effect of story was found. This effect was always due to the "Noise" text being more difficult than the "Desert" text. As the

effect of stories did not enter into any interactions, the data were combined across stories for purposes of the analyses.

In addition, there was rarely an effect found for the second variable, constrained or unconstrained summary. The exception will be noted in the text. The unconstrained summaries were longer than the constrained summaries at all ages, and at all ages the students obeyed the length restriction of the constrained summaries.

All of the analyses of variance were mixed, with Age (grades 5, 7, 10, and college) as the between subjects variable and Story (Noise/Desert) and Summary Type (Constrained/Unconstrained) as within subject variables. All analyses were conducted on the arc sine tranformed mean proportion of occurrences of rule use.

Both of the deletion rules, delete trivia or delete redundancy, were used effectively by all age groups (see Table 1). An analysis of variance

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Insert Table 1 About Here

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revealed no significant effects. Performance was consistently in the 90% range or better. Subjects as young as fifth grade are able to delete both trivial information (replicating Brown, Day, & Jones, in press) and redundant material. Even though the redundant material was important to the theme, fifth graders can omit it from their summaries. This is an important finding for it confirms that the younger children in this study were able to employ at least some of the rules of summary, and were not

just experimental foils used to provide a baseline against which improvement with age could be measured.

Consider next the superordination rule. Faced with text segments where this rule can be applied, there are four options open to the subject: (1) delete the unit entirely, (2) repeat it exactly, (3) use a superordinate inefficiently, and (4) use a superordinate efficiently. For example, consider a unit of the "Desert" text: "Daisies, poppies, marigolds, and lilies stay in the form of seeds." The unit could be deleted because that unit of text will not be featured in the summary (1). If it were included at all it can be repeated verbatim (2) or an attempt to use a superordinate can be made. Efficient superordination (4) would be when the superordinate "desert flowers," "flowers," or "annual flowers" is substituted for the subordinate list. Inefficient superordinate also occurred, where the subject included some of the subordinates with the superordinate, thereby failing to gain the full advantage of using the strategy (e.g., Flowers: poppies, and lilies stay in the form of seeds).

As can be seen in Table 2, older subjects are more likely to produce efficient superordinates on those occasions when they do not delete the

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Insert Table 2 About Here

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entire unit. To test this we computed for each subject the conditional probability of producing a good superordination given that the segment of text was not deleted. A mixed analysis of variance with Age (3) and

Stories (2) as between subjects variables and Summary Type as a within subjects variable was conducted on these conditional probabilities (arc sine transformation used). Only three ages were included in the formal analysis because the fifth graders deleted so many of the superordination units. The analysis revealed a main effect of Age, $F(2,41) = 12.76$, $p < .001$ and of Summary Type, $F(1,41) = 29.70$, $p < .001$. All subjects used the superordination rule more efficiently under space pressure than when unconstrained by a word limit, and the probability of using the rule effectively increased with age. Post-hoc tests revealed that the age difference was carried by the seventh graders performing less well than the older subjects. Seventh graders tended to repeat (.33) or use the rule inefficiently (.20) rather than efficiently when unconstrained by space pressure. Even under constrained conditions approximately half of the seventh graders' responses are repetitious and poor (.30) rather than good (.31). By contrast, tenth graders and college students rarely repeat (.04) or use the rule inefficiently (.06) when constrained by a word limitation.

Age differences in the use of the selection rule were also apparent. The selection data are shown in Table 3. The main effects of Age,

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Insert Table 3 About Here

$F(3,67) = 14.43$, $p < .001$, Summary Type, $F(1,67) = 9.59$, $p < .002$, and Story, $F(1,67) = 20.79$, $p < .001$ were all reliable, as was the Age x Summary Type interaction, $F(3,67) = 2.82$, $p < .05$. Use of the selection

rule increased with age in both conditions. There were no differences between conditions for the younger groups, however, college students decreased their use of the selection rule when constrained by a word limitation. One explanation for this finding is that mature summarizers, when pressed for space, drop the selection rule which is somewhat space consuming, and substitute a more oblique form of reduction, similar to invention, i.e., they combined across paragraphs and expressed the essential gist of large bodies of text in few words. Therefore, they did not receive a score for using the available topic sentences of several paragraphs. This is a common strategy of expert summarizers (see Experiment 2).

The final rule to be considered is that of invention. The mean proportion of invention rule use is also presented in Table 3. Analysis of variance resulted in a main effect of Age, $F(3,67) = 18.42$, $p < .001$ but no other main effects or interactions were reliable. The ability to invent explicit topic sentences to state the implicit main idea of paragraphs is difficult, and develops with age. Use of the invention rule by fifth graders was a rare occurrence. College students invent but only on half of the occasions when it would be appropriate to do so.

In summary, even fifth graders know how to delete trivial or redundant elements of simple texts, but older subjects outperform younger subjects in the use of more complex condensation rules. When required to use a superordinate substitution rule, college students and tenth graders produced good superordinates, but younger children use the superordinate

rules less frequently, and when they do attempt to use the rule they often use it inefficiently. The use of selection gradually increases with age as does invention. The invention rule is the most difficult, with very little use of the rule made by fifth and seventh graders. Tenth graders use the rule on one-third of appropriate occasions and even college students use the rule only on half of the units where it would be appropriate.

Given that even college students demonstrated considerable room for improvement, particularly in their use of the invention rule, we decided next to examine the efficiency of "experts" in applying the five basic rules of summary.

EXPERIMENT 2

Methods

Subjects. We contacted six fourth year graduate students in the English Department at the University of Illinois who had taught freshman rhetoric courses at least twice. From that sample, we selected two cooperative subjects who were able to comply with the talk-aloud procedure while attempting to summarize and who performed well on an initial test of summarization skills. Note that these subjects, in addition to their greater experience, were more highly selected than the undergraduates who took part in Experiment 1 (see Experiment 3 for a discussion of the samples included in these studies).

Procedure. The experts worked on the same passage used in Experiment 1. For the first passage, the procedure was identical to Experiment 1, with subjects writing both a constrained (60 words) and an unconstrained

summary of the text. Two weeks after completing the standard assignment we presented the second text (text order counterbalanced) and again asked the subjects to prepare an unconstrained version followed by a 60 word summary. However, we preceded this second session by asking subjects about how they taught summarization skills to their students and what they thought were the basic rules of a good summary. In addition, during their actual attempt to provide a summary, we asked them to "talk-aloud" while working. They were asked to try to tell us what they were doing; they were told to tell us anything that came to mind, no matter how trivial, and to describe the processes they went through as they worked. We asked them to reflect on what they were doing and to describe any general rules they were conscious of using. These protocols were tape recorded and transcribed.

Results and discussion. Consider first the rule use data comparable to that gathered from the students in Experiment 1. As expected, performance on the deletion rules was almost perfect, and no further consideration was given to these data. The experts' data on the remaining rules are presented in Figure 1, together with the comparable data from first year undergraduates (from Experiment 1) and first year students from

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Insert Figure 1 About Here

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junior college (from Experiment 3). The experts used the superordination rule perfectly compared to the 70% level set by the four-year college students. There were no differences between populations in the use of the

selection rule. However, the experts used the difficult invention rule much more than did the four-year college students (.84 vs. .49). Indeed, a case could be made that the experts performed perfectly because on the rare occasions that they did not receive a "correct score" for invention use, they had combined two paragraphs into one, thereby losing credit for one topic sentence use. This strategy of combining across paragraphs was also largely responsible for the somewhat low performance on the selection strategy. Combining two paragraphs and using one topic sentence for both depressed scores on the selection rule, an obvious limitation to the scoring system that had not been a problem when considering the protocols of the less experienced students. Rarely did any of the high school students combine paragraphs. Experts, however, favored the paragraph combining strategy and attempted to use it whenever possible.

Consider now the verbal protocols. In the open-ended interviews prior to actually summarizing, the experts showed a surprising lack of evidence that they knew any effective rules for summarization. Their description of what a good summary was, and what to tell students, was essentially similar to that contained in rhetoric text books (Bessey & Coffin, 1934). They stressed that a summary is a concise statement of the theme and that one should avoid unnecessary repetition, be concise, include only main ideas, etc., but there was no mention of a systematic set of rules for accomplishing this end.

During their attempt to summarize, however, the experts made frequent mention of the basic rules. The protocols were long and discursive. Forty percent of the comments were judged to be a statement of a rule, 14% were judged to be irrelevant and 45% of the discourse focused on passage content. Of the statements judged to be a reference to rule use, 68% were an explicit statement of one of the five rules. Examples of verbatim statements are given in Table 4.

Insert Table 4 About Here

These experts were unable or unwilling to give a precise statement of the rules that might be used prior to attempting to summarize a text. They spoke in very general terms about finding "main ideas" and "being concise," etc. As Ericsson and Simon (1980) point out, although verbal reports can provide invaluable data concerning human cognitive processing, the least likely procedure for obtaining accurate verbal descriptions is where subjects are asked to report retrospectively about how they might act generally in imaginary situations (see also Brown, Bransford, Ferrara, & Campione, in press, for a discussion of this point). In confirmation, the experts here were less than informative when asked to talk in general terms about the processes of summarization. In contrast, however, in the concurrent verbalizations, produced when they were faced with the task of summarizing a passage, they were much more explicit about the rules they were employing. Again, as Ericsson and Simon point out, requiring on-line

reporting of specific cognitive processes that the subject is actually using is a more optimal procedure for eliciting reliable and informative verbal reports. Under these procedures the experts reported the use of specific rules for summarizing texts; and, for the most part, the rules they described were the five basic rules of deletion, superordination and topic sentence manipulation.

In addition, it was observed that the experts' general procedure differed sharply from that of the younger children in Experiment 1 who went through the text sequentially deleting or copying segments. Experts accorded special status to the topic sentence, selecting or inventing them first and then writing their summary around and in support of the topic sentences. The only other dominant rule that was used by experts and repeatedly appeared in the protocols was the combining-paragraphs (see Table 4). Experts used the rule routinely. Younger subjects rarely attempted to combine across paragraphs, seeming instead to be "captured" by the paragraph structure provided in the input passage.

EXPERIMENT 3

Having examined experts' summarization performance, we turn now to novices. In order to examine the diagnostic value of our age norms, we repeated Experiment 1 using junior college students, a population thought to experience difficulty employing basic skills of critical reading and studying. A consideration of the traditional educational research literature would suggest that junior college students are not alone in their difficulty with the task of adequately abbreviating text; elementary

school children (Germane, 1921a, 1921b) and Air Force recruits (Stordahl & Christensen, 1956) demonstrate poor summarizing skills. In fact, summarizing is just one of several study techniques that immature students fail to employ well (Anderson & Armbruster, in press). For example, educators complain that high school students (Dynes, 1932; Beauchamp, 1923; Germane, 1921b), recruits for the armed forces (Weinstein, 1978; Stordahl & Christensen, 1956) and even some college undergraduates (McClusky & Dolch, 1924) lack basic notetaking and/or outlining skills and early observations of high school students' study habits revealed that their notes and summaries tend to be written somewhat indiscriminately, with equal weight given to major and to minor points (Germane, 1921a; Beauchamp, 1923). An examination of the validity of these traditional claims, using our sensitive diagnosis of rule use, seemed timely.

Methods

Subjects. Twenty freshman students attending a Central Illinois junior college served as subjects. All were enrolled in an English course that fulfilled the freshman rhetoric requirement at that college and at many four-year universities. That is, students could receive credit for this course should they continue their education at a four-year institution. The students were not, therefore, diagnosed as having any reading or writing problems on the basis of tests administered on entry to the college. In general, they were in a college preparation stream. English was their first language.

It should be pointed out, however, that given the selection of students entering junior college and the University of Illinois, the sample of students would be expected to have lower scholastic achievement. According to the Illinois Board of Higher Education, approximately 25% of college-age students enroll in four-year institutions. Given that the University of Illinois is one of the most prestigious in the State and has the highest entry requirements of all the State colleges, it can be assumed that the college students taking part in Experiment 1 were at least in the top 25% of the distribution and more likely at the upper end of that 25%. In contrast, an additional 43% of college-age students attend junior colleges in the State. As the junior colleges have no entry requirements beyond high school graduation, it can be assumed that the junior college sample of Experiment 3 would be at the middle range of the distribution of academic credentials. In short, the junior college students came from the same population as the "normal" high school students of Study 1 with the top 25% selected out.

Materials. The materials were the same as those used in Experiment 1.

Procedure. The procedure was the same as that used with the college students in Experiment 1. Subjects were seen for about one hour in small groups during which they wrote four summaries, one unconstrained and one of 60 words on each of two texts. Subjects had the texts available to them throughout the experiment so they could refer back to them while writing their summaries. In addition, scratch paper was provided and students were told that they could take notes, write a draft or mark the text; they were

permitted to use any method to facilitate producing good summaries except using the unconstrained summary to write the 60-word version.

Results and discussion. Summaries were typed onto index cards and two independent raters scored them for rule use. All analyses were carried out on the arc sine transformed mean proportion of occurrences of rule use. Stories were treated as a fixed effect.

Junior college students demonstrated a rudimentary understanding of the summarization task by deleting trivial and redundant information. Junior college students eliminated 92% of the unimportant and 94% of the redundant material. Junior college students compared favorably to the four-year university students of Experiment 1, who deleted 93% of the trivial and 95% of the redundant information.

Performance on the remaining three rules was generally at a level set by seventh-tenth graders and considerably less efficient than that of the four-year college populations. For comparative purposes, the junior college performance (collapsed across Summary Type and Stories) is shown in Figure 1, together with the comparable data from experts and four-year college students.

Consider first the superordination rule. The conditional probability of efficient superordination on the unconstrained summary was .45 for junior college subjects compared with .28 for seventh graders and .60 for tenth graders in Experiment 2 ($p < .05$). On the constrained summary, the conditional probability of an efficient superordination was .69 for junior college students compared with .51 for seventh graders and .82 for tenth

graders ($p < .05$). On this rule the junior college performance fell approximately midway between seventh and tenth grade performance levels.

Junior college students had particular difficulty dealing with the selection and invention rules. These data are also included in Figure 1. Analysis of variance comparing junior college students' selection rule use to that of the seventh graders and college students of Experiment 1 suggested that the junior college students were performing on essentially a seventh grade level but significantly worse than four-year college students, $F(1,38) = 16.03$, $p < .001$. The only time junior college students appeared to do better than seventh graders was on the unconstrained summary (grade x summary type interaction, $F(1,38) = 6.95$, $p < .05$), but when pressed for space, both groups performed equally (poorly).

Junior college students' use of the invention rule was also poor, as shown in Figure 1. Again junior college students performed at approximately the level set by seventh graders and significantly less well than four-year college students, $F(1,38) = 20.16$, $p < .001$.

Confirming the global claims of educational psychologists, it would appear that students from less academically privileged backgrounds perform poorly on a variety of text-processing strategies, including summarization. These data take us beyond this global claim by providing a more fine grained analysis of where the students are experiencing particular problems. The ability to delete trivial or redundant material is intact, at least with the very simple expository materials used in these studies. The strategies needed for adequate manipulation of topic sentence rules

are, however, much more problematic for these students. Junior college students, even those with no diagnosed reading or writing problems, perform on a level comparable to that of seventh graders from regular junior high schools.

GENERAL DISCUSSION

This series of studies provide empirical confirmation of the Kintsch and van Dijk (1978) theory of prose comprehension. By applying a scoring system based on the most common macrorules, it was possible to capture the flavor of much of the data. However, it should be noted that the more mature summarizers differed from the immature in ways that were not captured by the simplified scoring procedure. First, and most obviously, the raters had no difficulty identifying the product of the less mature writers, and, indeed, it was necessary to instruct them to ignore style and concentrate only on rule use when scoring. Quite simply, college students and experts write better as well as use rules more efficiently. Another obvious developmental difference was the marked tendency on the part of the more mature subjects to rearrange material across paragraphs, combining according to common topic. This was a popular strategy used by experts in this study and reported previously as symptomatic of college students (Brown, Day, & Jones, in press).

Another subtle condensation manipulation used by the more experienced students was the tendency to capitalize on inferential reasoning. For example, one expert reported using this ploy deliberately. "The audience should be aware that the animals were waiting during the day or sleeping

during the day due to the heat, they can make that conclusion themselves, it is not necessary to make it explicit that the animals are waiting because of the heat of the day and that the desert temperature becomes cooler during the night." Subtle writing procedures that rely on the readers' inferential reasoning abilities were not captured by the crude scoring procedures used here, and they certainly deserve future attention.

The developmental data extend the Kintsch and van Dijk (1978) model that is silent with respect to the differential difficulty of applying the macrorules. Throughout this series of studies a clear developmental pattern was found, with deletion rules emerging first followed by superordination and then selection. Invention, the most difficult rule, was late developing. We believe that the five rules differ in their ease of application because they demand different degrees of text manipulation on the part of the learner, and perhaps because they depart to a greater or lesser extent from the already existing strategy favored by the younger participants. This has been called the copy-delete strategy (Brown, 1981; Brown, Day, & Jones, in press) because fifth and seventh grade and junior college students summarize texts primarily by deleting, or copying near verbatim the words actually present in the text.

Consider the five rules of deletion, superordination and topic sentence manipulation in terms of how far they depart from the copy-delete strategy. Obviously, the easy deletion rules map straight onto the existing strategy; unnecessary material is merely deleted. Copy-delete works quite well for superordination with the minor departure that the

students must add a superordinate in place of a deleted list. But in order to use the topic sentence rules appropriately, the students must abandon either the sequential unit by unit approach or both the sequential approach and the copy-delete principle. To use the selection rule, the students must have some realization of the unique status of the topic sentences. This would demand disrupting the sequentiality rule and giving unique status to topic sentences, for example, by selecting them first to form the scaffolding of the summary as experts do (see Experiment 2). The main feature of the copy-delete rule still applies, however, in that one can copy the selected topic sentence straight from the text.

The invention rule is difficult because it departs most radically from the favored copy-delete ploy. Students must now add something of their own, a synopsis in their own words of the implicit meaning of the paragraph. The invention rule, therefore, requires that the students add information rather than just delete, select or manipulate sentences already provided for them. It is these processes that are the essence of good summarization, that are used with facility by experts and that are most difficult for novice learners.

On a more speculative note, there is evidence that partially adequate strategies such as copy-delete are not just way-stations on the road to expert strategies; they may actually impede progress. Copy-delete is a partially adequate strategy in that it results in a product that is recognizably a summary, an outline, or a set of notes and teachers will accept the product as adequate (Brown, 1981). Bereiter and Scardamalia (in

press) describe another partially adequate writing strategy adopted by novice writers. A common composition tactic of young writers is to tell all they know on a topic irrespective of the writing assignment. For example, when writing an essay on winter, the child might begin with "I think winter is the best time of year because you can make snowmen"; the child will then proceed for many more sentences telling all she knows about snowmen. Having exhausted that topic, the child will declare that the composition is ended, seemingly having "forgotten" the original purpose of the essay. This general ploy is referred to as the knowledge-telling strategy (Bereiter & Scardamalia, in press).

The knowledge-telling strategy is a device favored by many novice, and not so novice, writers. And it bears many similarities to the copy-delete strategy; like the copy-delete strategy, the knowledge-telling strategy is difficult to eradicate because it is partially successful. Knowledge-telling results in a recognizable product acceptable to teachers. Writing gets done.

Bereiter and Scardamalia argue that the knowledge-telling strategy gives way to reader-based, responsive, mature writing only with great difficulty because of the partial success of the inadequate strategy. We would like to argue that partially adequate strategies such as copy-delete and knowledge-telling are maintained by inexperienced writers because they do result in intermittent reinforcement and are recognizable attempts to get the job done. The process of development is not just one of acquiring increasingly more refined and sophisticated strategies; development

involves the systematic consolidation of mature strategies, combined with the rejection of plausible but less efficient habits (Brown, Bransford, Ferrara, & Campione, in press).

Finally, the studies can be characterized as exercises in applied cognitive science, or cognitive engineering (Norman, 1979). Taking as a starting point a basic theory of prose comprehension (Kintsch & van Dyke, 1978), we proceeded to map the developmental progression associated with the passage from novice to expert. This information enabled us to go beyond the global claim that immature students experience difficulty with text processing, including summarization, and to identify specific operations that prove particularly troublesome at certain stages in the developmental progression. Diagnosis of the exact location of the difficulty implicated that rules of selecting, and particularly inventing, topic sentences are particularly difficult for younger children and for junior college students, even those with no diagnosed reading and writing problems. Even four-year college students perform less well than experts on two indices of efficiency, the ability to combine information across paragraphs and the ability to provide a synopsis of a paragraph in the absence of an explicitly stated topic sentence. One advantage of these more precise, theory-driven diagnoses is that remediation can be tailored to a student's specific weaknesses. Attempts to devise such student-responsive training have proved successful (Brown, Campione, & Day, 1981; Day, 1980).

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FOOTNOTES

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[1]Copies of the stories used in these studies are available from the authors.

Table 1

Use of Deletion Rules

Material	Trivial Units		Redundant Units	
Summary	Unconstrained	Constrained	Unconstrained	Constrained
Age				
5th grade	.91	.95	.97	.96
7th grade	.85	.93	.92	.95
10th grade	.82	.91	.92	.93
College	.90	.95	.91	.98

Table 2

Use of Superordination Rule

	Unconstrained Summary				60-Word Summary			
Age	5th	7th	10th	College	5th	7th	10th	College
Delete entire sentence	.57	.27	.19	.22	.54	.39	.33	.36
Repeat entire sentence	.11	.33	.23	.10	.10	.20	.06	.03
Superordination:								
Efficient	.17	.21	.46	.42	.26	.31	.54	.55
Inefficient	.14	.20	.12	.28	.10	.10	.06	.07
P/Efficient given not deleted	.44	.28	.60	.56	.52	.51	.82	.85

Table 3

Use of Selection and Invention Rule

Rule	Selection		Invention	
Summary Type	Unconstrained	Constrained	Unconstrained	Constrained
Age				
5th grade	.29	.28	.14	.14
7th grade	.34	.33	.28	.23
10th grade	.56	.52	.36	.38
College	.72	.53	.52	.46

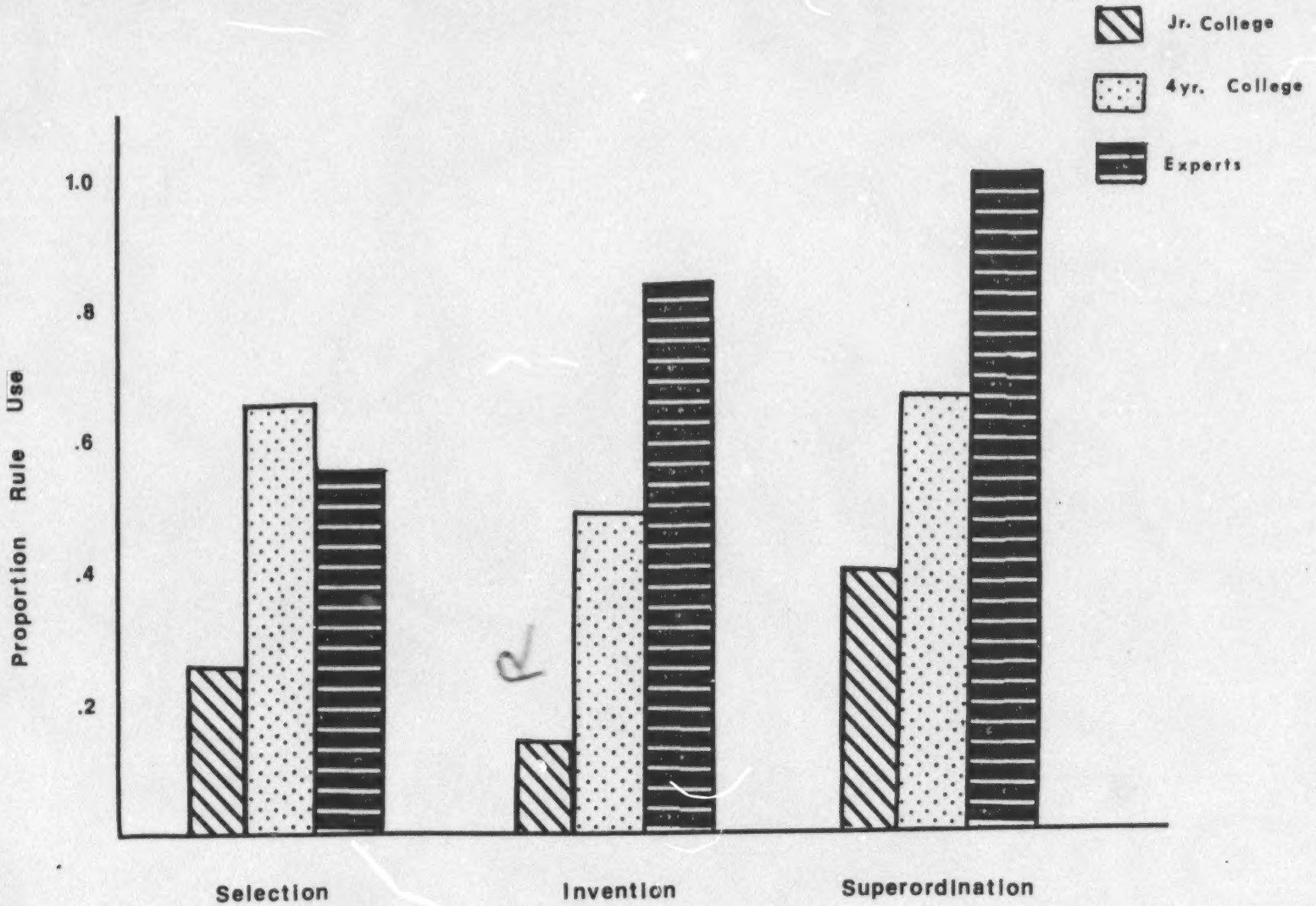
Table 4

Examples of Experts' Rule Verbalization

Deletions	"The details are dropped for a summary of this type. You need the generalizations, not the details." (trivia)
	"This essay wastes two sentences. Both state the simple fact that desert animals are nocturnal due to the heat. You can omit one." (redundancy)
Superordination	"One thing I've done is drop the kinds of plants. Instead of writing daisies, poppies, marigolds and lilies, all I've written is 'annual plants', again leaving out details and talking about generalization."
Topic Sentence Selection	"This sentence contains the essential point of the paragraph, it states the process by which plant life is maintained. It has to be included in any summary."
Topic Sentence Invention	"The paragraph is about the cycle of the annual plants that produce seeds, wait until rainfall, bloom, produce seeds again, etc. Although it doesn't say so explicitly, all you need is to state this cycle then you can drop the rest."
Combining Across Paragraphs	"In the first two paragraphs the only really essential information is the facts about the heat and the lack of water in the desert. I'll combine the first two paragraphs into only two sentences -- that contains all the information that I need. One sentence is simple, the other is a compound sentence."
	"On the third and fourth paragraphs, information is given about plant life. The third is about annual flowers and the fourth is about the cactus, a flower particular to the desert. Now, a lot of information is given there. The details can be dropped. And the two paragraphs can be combined to one single paragraphs since they both deal with plant life."

FIGURE CAPTION

Figure 1. Use of the selection, invention and superordination rules by college students of varying degrees of expertise.


Jr. College
4yr. College
Experts
Proportion Rule Use
1.0
.8
.6
.4
.2
Selection
Invention
Superordination